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**Sex Differences in Pre-Diagnosis Concerns for Children Later-Diagnosed with Autism
Spectrum Disorder**

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Abstract

In the absence of intellectual impairment, girls are diagnosed with autism spectrum disorder (ASD) significantly less and later than boys. This study explored potential reasons for why ASD may be more difficult to identify in girls, based on carer concerns during the pre-diagnosis period. Carers of 92 boys and 60 girls diagnosed with ASD from school age completed an online survey addressing concerns regarding the child's development during the pre-school years (pre-diagnosis). Significant sex differences were evident in key early concerns, as well as the strategies used to navigate pre-school social situations, and the types of restricted interests. Findings suggest, from carer perspective, that girls who went on to be diagnosed with autism spectrum disorder presented differently when compared to boys, providing insight into why the diagnosis of ASD may be more difficult to make with cognitively able girls.

Introduction

Autism Spectrum Disorder (ASD) is a pervasive developmental disorder characterised by impairments in social and communicative abilities, along with the presence of ritualistic and/or repetitive behaviours (American Psychiatric Association, 2013). One of the more consistent yet under-researched areas in the ASD literature is the large sex difference in the diagnosis rates. On average, the male to female ratio stands at 4.3:1, with this ratio increasing to around 9:1 in the absence of comorbid intellectual impairment (for review see, Rivet & Matson, 2011). There is also evidence that, compared to boys, ASD is diagnosed later in cognitively-able girls, despite there being no difference in the number of visits to a health care professional during the diagnostic process (Siklos & Kerns, 2007) and no difference in the age at which parents first express concern (Begeer et al., 2013). These findings suggest diagnosing the disorder in girls in the younger years is especially problematic, meaning many would miss early intervention. Further, it suggests that, while certain biological factors may protect girls from developing ASD as readily as boys (Baron-Cohen, 2002), the current magnitude of the sex discrepancy is also potentially due to the under-identification of the disorder in cognitively-able girls.

One hypothesis for why ASD may be missed or misdiagnosed in girls is that our current definition of ASD, and thus potentially how we measure and diagnose it, is based on a male-centric presentation that does not accurately reflect the disorder in girls (Gould & Ashton-Smith, 2011). Exploring sex differences on the core diagnostic domains of ASD comprises much of our current evidence of sex differences in ASD. However, when controlling for IQ, evidence largely demonstrates no sex differences across the social criteria for ASD (for review see Van Wijngaarden-Cremers et al., 2014). This includes studies that have used standardised diagnostic tools (e.g., Mandy et al., 2012; McLennan et al., 1993) and those based on clinician ratings using the new DSM-5 criteria (Hiller, Young & Weber,

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2014). Indeed, the only consistent difference to emerge across the core symptoms of ASD is that fewer girls than boys present with restricted interests (Hartley & Sikora, 2009; Hiller et al., 2014; Lord, Schopler, & Revicki, 1982; Mandy et al., 2012). However, clinical experience (Attwood et al., 2006) and recent empirical evidence (Hiller et al., 2014) suggest girls present with different types of restricted interests to boys, which may be more difficult to identify as atypical. As such, current evidence of girls presenting with less restricted interests may be partially due to the under-detection of how these interests manifest in girls.

Another hypothesis for why ASD may be more difficult to detect in cognitively-able girls is that the associated signs of the disorder (e.g., poor imitation, externalising behaviour) present differently. Additionally, it has been suggested that cognitively-able girls are better able to engage in social strategies that further add to the difficulty of identifying potential signs of the disorder (Attwood et al., 2006). Such features, while outside of the core criteria, will likely influence the behaviour presentation of the child and thus impact whether a medical professional or clinician will explore whether developmental concerns may be a sign of ASD. However, there is a paucity of research on sex differences in the broader features of ASD. The few studies that have explored broader features of the disorder have largely presented inconsistent findings. For example, there is evidence of females with ASD having both higher (Hartley & Sikora 2009) and lower (McLennan et al., 1993) internalising problems. Interestingly, a recent finding to emerge is that teachers report far fewer concerns with externalising behaviour problems for girls compared to boys with ASD (Dworzynski et al., 2012; Hiller et al., 2014; Mandy et al., 2012). This finding may lend some support to the hypothesis that, in certain settings, girls' behaviour may inadvertently mask their underlying impairment. However, thus far there has been no exploration of the specific strategies children with ASD use to manage early social settings, and whether this may impact on detection of the disorder in girls.

A key issue impacting our ability to draw conclusions on what may make ASD more difficult to identify in girls, is the continued focus on exploring sex differences in samples of children and adolescents post-ASD diagnosis. This particularly limits our ability to explore whether early, pre-diagnosis features of the disorder may present differently in girls, and thus lead to an under-detection of ASD, or a delay in obtaining an accurate diagnosis. To address this, the current study focusses on parental concern during the pre-diagnosis period for those children who would later be diagnosed with ASD. These are likely the concerns parents voiced to their family doctor or other clinician, who would then be tasked with deciding whether to pursue a diagnostic assessment. To extend our knowledge of why ASD may be more difficult to detect early in girls, this exploratory study had four aims, explored through the use of an online carer-report questionnaire. Our primary aim was to investigate sex differences in carers' pre-diagnosis concerns, for children who would go on to be diagnosed with ASD. This included concerns linked to the core criteria for ASD (e.g., social reciprocity) and associated features (e.g., imitation). The remaining three, secondary aims, were to explore carer perspective on (i) the response received from professionals regarding carer concern, (ii) whether girls do indeed engage in social strategies which may impact their overt social presentation, and (iii) the types of obsessional interests displayed by girls versus boys. To explore how these factors may make ASD more difficult to detect, we specifically focussed on those children who, despite early concerns, were not diagnosed until school aged (≥ 5 years old, so were not 'early-detected'). Given the limited consistent evidence for sex differences in ASD, and the absence of information on pre-diagnosis concerns, these aims were all exploratory in nature.

Method

Sample Characteristics

Recruitment and eligibility. This study was granted ethical approval by the university's behavioural research ethics committee. Over a six month period participants were recruited through State-wide Autism organisations in Australia (Autism Spectrum Australia, Autism Victoria, Autism SA, and Autism Western Australia) and two private practices, specialising in the diagnosis and treatment of individual's with ASD. One private practice was located in South Australia and the other was located in Victoria and were chosen as they were known to see higher numbers of girls than is typically seen in clinical settings. The project was advertised through flyers at these practices and through online advertisements on the websites of the autism organisations. One hundred and eighty seven people completed the online questionnaire. Of these, 171 (92%) identified themselves as the mother of the child, with the remaining identified as the father, grandmother, or foster-parent/carer. The majority of the children were from South Australia (30.4%), New South Wales (20.3%) and Victoria (13.9%). Twenty five percent of participants provided no information on locality.

To participate in the survey the child was required (1) to have a current diagnosis of ASD (including Asperger's Disorder), (2) to have no intellectual disability (i.e., cognitively-able), (3) to have been diagnosed after 5 years of age, and (4) to be currently aged between 5 and 18 years of age. Inclusion was determined based on carer report. Using these criteria, 152 surveys were eligible for inclusion. Thirty-five participants were excluded for either not providing the current age of the child, the age the child was diagnosed, or the child's current diagnosis.

Of the 152 eligible surveys 60 were completed for a female with ASD (39.5%) and 92 were reporting on a male (60.5%). The children ranged in age from 6 to 17 years old ($M =$

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10.94, $SD = 3.11$ years). On average, the girls were slightly younger ($M = 10.27$, $SD = 3.05$ years) than the boys ($M = 11.27$, $SD = 2.99$), $t(150) = 1.99$, $p = .05$, $d = .33$. As such, current age was controlled for in the major regression analyses. There were no sex differences in key factors that may impact a parents' astuteness to developmental concerns, including the birth order of the child ($p = .39$), infant health ($p = .75$) and the age at which they started walking ($p = .66$).

Current severity rating. Respondents were asked to report their perspective of the child's current level of functioning based on the severity rating scales used in the fifth edition of the Diagnostic and Statistical Manual (DSM-5; American Psychiatric Association, 2013).¹ The level of perceived support required on each domain did not significantly differ by sex (social: $\chi^2(2) = .10$, $p = .95$, $\phi_c = .03$; ritualistic: $\chi^2(2) = 1.91$, $p = .39$, $\phi_c = .11$). On the social domain, based on carer perspective, the majority of children required minimal support ($n = 109$, 79.0%), 22 (15.9%) required moderate support and 5 (3.6%) required significant support (very substantial). Again, on the ritualistic domain, based on carer perspective, the majority of children required minimal support ($n = 86$, 62.3%), 41 (29.7%) required moderate support and 9 (6.5%) required significant support.

¹ At the time of data collection these rating scales were at a proposal stage, but now form part of the official ASD criteria in DSM-5.

Table 1

Age and Timing of Concern and Diagnosis in Years

Timing	Girls <i>M (SD)</i>	Boys <i>M (SD)</i>	Significance of group difference
Age of first concern	3.17 (2.49)	3.35 (2.14)	$t = 0.40, p = .68, d = .07$
Age of diagnosis	9.24 (3.00)	8.45 (2.26)	$t = -1.56, p = .12, d = .26$
Time from concern to diagnosis	6.07 (2.67)	5.21 (2.67)	$t = -1.60, p = .11, d = .29$
Time since first concern ^a	7.87 (3.21)	7.07 (3.82)	$t = 1.42, p = .16, d = .25$

^a This variable represents the years passed since the period of time when the parent first became concerned for the child.

Measure and Procedure

Respondents completed a 40-item online survey, with a combination of multiple-choice and free-response options (specified in more detail in the Results). The survey consisted of 15 items on general demographic information, diagnosis information and milestones (e.g., “At what age did your child learn to walk?”; “What type of school does your child attend?”), 20 items on general pre-school concerns (18 multiple-choice response format, including questions such as “Did you child like to line things up precisely and insist they weren’t disturbed?”; “From ages 3-5 was there a problem with your child hitting, pinching, biting or injuring themselves or others?” and two free-report items on social concerns), three items on responses from professionals (e.g., “When you first expressed concern to a medical professional regarding your concerns, what response was given?”), one item on social strategies (free-report on the main strategy the child used to navigate social environments), and one item on repetitive/ritualistic behaviours (free-report on child’s main obsession). The majority of questions pertained to the child’s functioning during the pre-school years. Seventeen of these items (from the ‘general pre-school concerns category’) were multiple-

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choice response items that were based on key characteristics that are common early signs of ASD (e.g., ability to manage change, imitation, sensory sensitivity, emotion recognition), and were based on items found in standardised diagnostic instruments (e.g., the Autism Diagnostic Interview-Revised: Lord et al., 1994; Diagnostic E-2 Checklist: Rimland, 1971; Autism Detection in Early Childhood: Young, 2007). These seventeen items had adequate internal reliability ($\alpha = .73$).² Additional items were added to explore other important theoretical questions, not covered in standardised instruments but potentially important in explaining why ASD may be harder to diagnose in girls (e.g., what strategies are used to manage social situations, types of obsessions, responses of medical and teaching professionals). For questions that used a free-report format, a coder blind to child sex and research aims coded 25% of the responses, with acceptable interrater reliability across all free-report questions (Cohen's $\kappa = .78-.89$).

Statistical Analyses

As this study was exploratory, and not based on priori hypotheses, to address our primary research aim we used a backward stepwise logistic regression to determine what group of key early signs of ASD best predicted sex (explained in more detail in Results). For the major analyses logistic regressions were used, with sex as the outcome variable. This analysis directly addresses the key research question: How strongly is a given predictor indicative of a child being a girl (or boy)? Consequently, these analyses provide more useful information than simply examining sex differences in proportions or means of predictor variables. We used the logistic regression equations to calculate the predicted odds for each level of all significant predictors (described in more detail in the Results section). Odds ratios are an effect size measure and, therefore, provide an index of the strength of association

² Overall internal consistency was not calculated as the measure was designed so each question explored a different construct. There were significant associations between the number of pre-school concerns endorsed by the carer and their rating of the level of support the child currently needed with social ($r = .22, p = .017$) and ritualistic behaviour ($r = .32, p < .001$).

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between the predictor in question and sex. Odds ratios are asymmetrical around 1, meaning it is difficult to compare odds ratios favouring girls (>1) with those favouring boys (<1). For ease of interpretation, we transformed all odds ratios to >1 and have noted whether the ratio favours girls or boys. Consequently, a larger odds ratio is indicative of a stronger association between sex and the predictor variable. A final issue to consider when interpreting the logistic regression results was the imbalanced sex ratio in our sample (92 boys versus 60 girls). As a consequence of this, the predicted odds ratios from the logistic regressions reflect this imbalance. However, this makes interpretation difficult. To overcome this, ratios predictive of being a boy were multiplied by 0.65 (number of girls/number of boys; 60/92) while ratios predictive of being a girl were multiplied by 1.53 (number of boys/number of girls). As such, results represent the predicted odds of being either a boy or girl, based on there being an even proportion of each sex.

Results

Preliminary Analyses: Diagnosis and Age of Concern

The largest percentage of children had been diagnosed with Asperger's Disorder (girls: 81.7%, $n = 49$; boys: 63.0%, $n = 58$). Autistic Disorder was the diagnosis for 26.1% of boys ($n = 24$) and 11.7% of girls ($n = 7$). Ten boys (10.9%) and four girls (6.7%) had a diagnosis of Pervasive Developmental Disorder Not Otherwise Specified (PDD NOS).³ Supporting the higher-cognitive functioning of the sample, all except one child attended mainstream schooling (with five of those children spending time in a disability specific class, within the mainstream system). The one child who did not attend a mainstream school, attended a disability specific school.

³ There was no significant sex difference in the category of diagnosis, $\chi^2(2) = 6.19$, $p > .05$, $\phi_c = .20$. That said, given evidence of a trend, to be conservative, we have taken diagnosis into account in the later major analyses. While diagnosis was made using DSM-IV-TR, in line with recommendations made in the new DSM-5, the umbrella term of Autism Spectrum Disorder (ASD) will be used throughout the paper (American Psychiatric Association, 2013).

There was no significant sex differences between the age of first concern, the age of diagnosis, the time passed between first concern and diagnosis, or the time passed between pre-school concerns (i.e., the period of interest) and the present (see Table 1). Regardless of sex, concern with development first became apparent, on average, around 3 years of age, while an official diagnosis was given around nine years old. This represents an average wait of approximately six years between first concern and receiving a diagnosis. This age of diagnosis is in line with the expected older age of diagnosis for children diagnosed with Asperger's Disorder (Howlin & Asgharian, 1999), and our specific focus on children diagnosed from school age.

Pre-Diagnosis Concerns for Children Later Diagnosed with ASD

The primary aim of this research was to explore early (pre-diagnosis) carer concern for children who would go on to receive a diagnosis of ASD. Before exploring overall pre-school concerns, we asked carers to report on the very first concern they held for their child and then free-report on the primary concern they had for their child's behaviour in a social setting. Response options for the carer's first concern were (i) language, (ii) social, (iii) routine dependence, (iv) motor skills, (v) behaviour, and (vi) medical issues. Overall, the first concern for development did not significantly predict sex, $Wald(5) = 8.61, p = .13$.

Caregivers most common initial concern for the child's development was difficulties with behaviour (girls: $n = 23, 39.7\%$; boys: $n = 19, 21.6\%$). Besides behaviour concerns, reporting on the first concern held for girls was distributed evenly across the other concerns (see above for list of concerns). For boys, 21.6% of participants reported first being concerned with medical issues, while 20.5% were first concerned with language development.

Responses regarding concern for behaviour in a social setting were coded as either (i) concern with externalising social behaviour (e.g., hitting, yelling, controlling play) or (ii) concern with internalising/withdrawal (e.g., avoidance, remaining passive). Compared to

those children for whom internalising social behaviours were of primary concern, reporting the primary concern as externalising behaviour was predictive of being female, $Wald(1) = 6.02, p = .01, B = 1.06, SE = .43, OR = 2.89, 95\% CI [1.24, 6.71]$. Externalising behaviour was reported as the primary concern in a social setting for half of the girls and only a quarter of the boys. See Table 2 for results of logistic regression.

Exploratory analysis of key early signs. As previously discussed, 17 items were multiple-choice response-format items that pertained to concerns commonly seen as early signs of ASD, based on those items typically explored in standardised early identification diagnostic measures. This included items on a range of possible concerns, including sensory sensitivity, friendships and aggression. The full list of these items is presented at the bottom of Table 2. As the analysis of these concerns was completely exploratory, a backward stepwise logistic regression was used to determine the group of early concerns that best predicted sex.⁴ These items were recoded into dichotomous variables, as either concern or no concern. The only exception to this was imitation, which was coded as simple imitation or complex imitation. From the 17 items included in the regression, five significantly predicted sex $\chi^2(6) = 22.50, p = .001$. These items were: (i) imitation complexity ('Before the age of 3, did you child ever imitate another person?'), (ii) withdrawn ('Would you describe your child around age 3-5years as often seeming withdrawn or distant?'), (iii) interest in parts of mechanical objects ('From 3-5 years of age was your child unusually interested in mechanical objects such as the stove or vacuum?'), (iv) desire to be liked ('During the pre-school years did your child seem to want to be liked by other children?'), and (v) vocabulary ('How would you judge your child's vocabulary below the age of 5 years?').

Following the exploratory analysis to identify key predictors, logistic regressions, controlling for age, were then used to explore whether each of these items, using their

⁴ Multicollinearity was assessed and it was found that no items correlated above $r = .32$.

original response formats, would predict sex differences (see Table 2 for results). Based on these analyses the only item to not significantly predict sex was ‘presenting as withdrawn or distant’ ($Wald(2) = 1.93, p = .38$). All other variables remained predictive of sex. In particular, based on odds ratios (with confidence intervals; see Table 2), imitation ability and interest in mechanical objects were strong predictors of sex. Over 70% ($n = 36$) of girls were reportedly able to engage in complex imitation (i.e., imitation games or multiple actions), compared to 34% ($n = 30$) of boys. Indeed, based on predicted odds ratios, if the carer reported that the child had engaged in complex imitation during the pre-school years (e.g., imitation games), they were over five times more likely to be a girl rather than boy. The majority of girls were rated as having either little or no interest in parts of mechanical objects (48%, $n = 28$, versus 15% of boys, $n = 13$), while boys were most commonly rated as fascinated ($n = 49$, 55%, versus 26% of girls, $n = 15$). If the carer reported that the child had no interest in parts of mechanical objects the child was over three times more likely to be a girl. Results also revealed that, based on carer perception, girls were more likely to have an unusually strong desire to be liked by peers and more advanced vocabulary than boys; although the lower limit of the odds ratio confidence intervals suggest that these effects may be smaller (see Table 2). Almost a quarter of girls reportedly had an unusually strong desire to be liked ($n = 13$, 22%) compared to only 10% of boys ($n = 9$). Finally, boys were reported as more likely to present with below average vocabulary ($n = 37$, 42%) compared to girls ($n = 16$, 28%). Indeed, the largest percentage of girls were rated as having above average vocabulary in the pre-school years ($n = 26$, 46%) versus 29% ($n = 26$) of boys.⁵

⁵ Although there was no significant sex difference in the percentage of boys and girls diagnosed with Asperger’s Disorder, Autistic Disorder, or PDD NOS, approximately 20% more girls were reported to have a current diagnosis of Asperger’s Disorder. Under DSM-IV-TR, a diagnosis of Asperger’s Disorder meant language impairment was not present (American Psychiatric Association, 2000). Consequently, for the purpose of clarity, we also explored whether each of these variables would still predict sex after controlling for diagnosis and age (rather than age alone). Unsurprisingly, the only variable affected was vocabulary, which no longer significantly predicted sex after controlling for diagnosis. Specifically, after controlling for diagnosis, having below average vocabulary no longer predicted being a boy, $p = .34$, $ExpB = 0.64$, 95% CI [0.26, 1.59].

Table 2

Results from Logistic Regressions on Individual Items that Significantly Predicted Gender

Item	Predicted Odds	Wald(df)	p	ExpB [95% CI]
First Social Concern				
Internalising*	1.86	6.02(1)	.01	0.35 [0.15; .81]
Externalising*	<u>3.47</u>	5.12(1)	.02	6.54 [1.28; 3.51]
(constant)				
Imitation		14.09(4)	.01	-
Simple imitation	1.13	0.01(1)	.91	1.09 [0.26; 4.48]
Imitation game*	<u>5.12</u>	5.51(1)	.02	4.92 [1.30; 18.57]
Complex Imitation*	<u>5.84</u>	7.04(1)	.01	5.62 [1.57; 20.10]
Not sure	<u>2.76</u>	1.99(1)	.16	2.65 [0.69; 10.25]
No imitation	1.08	0.21(1)	.65	0.68 [0.13; 3.65]
(constant)				
Mechanical		19.04(2)	<.001	-
No interest*	<u>3.33</u>	18.60(1)	<.001	7.04 [2.90; 17.11]
Average interest	1.18	1.72(1)	.19	1.78 [0.75; 4.23]
Fascinated	2.10	0.72(1)	.96	0.97 [0.23; 3.94]
(constant)				
Desire to be liked		5.73(3)	.13	-
Unusually strong*	<u>6.50</u>	4.62(1)	.03	3.27 [1.11; 9.96]
Average	1.20	.002(1)	.97	0.98 [0.34; 2.82]
Indifferent	<u>3.24</u>	1.27(1)	.26	1.63 [0.70; 3.84]
Preference for	1.19	0.13(1)	.72	1.30 [0.31; 5.42]

solitary (constant)

Vocabulary		4.39(2)	.11	
Below average*	1.02	4.34(1)	.04	0.42 [0.19; 0.95]
Average	<u>3.47</u>	1.32(1)	.25	0.61 [0.26; 0.95]
Above average	<u>5.69</u>	2.91(1)	.09	3.72 [0.84; 12.94]
(constant)				

Note. Removed variables: response to light; response to being held; health; imitation; withdrawn presentation; lining up objects; destructive; managing change; aggression; providing comfort; friends; preparation to be picked up; play style. Underlined predicted odds ratios represent variables that predicted being a girl. CI = confidence interval.

* $p < .05$

Responses from Professionals

Medical professionals. As a secondary aim we also explored other factors that may have impacted on the ability to receive an early ASD diagnosis, one of which was the response from professionals regarding carer concern. Using a multiple-choice response option, participants reported on their perception of the responses received from their GP or paediatrician when they first voiced concern about the child's development. Responses were collapsed into four categories: (1) ambivalence/no concern ('nothing to worry about', 'every child develops differently'), (2) shy/anxious ('they are just shy'), (3) another issue identified (i.e., not ASD), and (4) ASD symptoms recognised or diagnosis given. A logistic regression, controlling for age, showed that responses given from medical professionals did not significantly predict sex, $Wald(3) = 2.11, p = .55$. Approximately 33% of participants reported 'ambivalence/no concern' as the initial response from a medical professional, while 36% had another diagnosis queried as the initial response. ASD symptoms were identified in 22% of children.

Over the pre-school years it was common for other diagnoses to be queried, with around one-third of the sample reporting no other diagnosis was queried (girls: 31%, $n = 16$; boys: 27%, $n = 22$). However, there was no sex difference in carer report of the primary other diagnosis queried, $Wald(4) = 6.48, p = .17$. Language disorder (girls: 28%, $n = 14$; boys: 15%, $n = 12$) and attention deficit hyperactivity disorder (girls: 24%, $n = 12$; boys: 32%, $n = 26$) were commonly queried. Other reported queries were anxiety (girls: 12%, $n = 6$; boys: 10%, $n = 8$) and global development delay (girls: 6%, $n = 3$; boys: 16%, $n = 13$).

Timing of teacher concern. Here, participants reported on the age of their child when a teacher first expressed concern. Reported timing of concern expressed by teachers predicted sex, $Wald(4) = 9.51, p = .05$ (see Table 3). Here, if it was reported that no teacher ever expressed concern for the child's development, the child was over 13 times more likely to be a girl. For a quarter of the girls in the sample, no teacher had reportedly ever expressed concern for their development or behaviour ($n = 15, 25\%$). This was rare for boys ($n = 6, 7\%$), with majority of boys ($n = 52, 62\%$) having a teacher report concern during the pre-school years.

Table 3

Logistic Regression Results for Timing of Teacher Concern Predicting Sex

Timing of Concern	Predicted Odds	<i>Wald(df)</i>	<i>p</i>	ExpB [95% CI]
Teacher concern (overall)		9.51 (4)	.05	-
No concern (constant)	<u>13.65</u>	6.59(1)	.01	8.93 [1.68; 47.46]
Childcare (<42mo)	1.34	5.17(1)	.02	0.24 [0.07; 0.82]
Pre-school (42-60mo)	1.01	8.61(1)	.003	0.18 [0.06; 0.57]
First year of school (61-72mo)	1.12	5.86(1)	.02	0.20 [0.05; 0.74]
Later primary (>72mo)	2.01	2.51(1)	.11	0.35 [0.09; 1.29]

Note. Underlined predictive odds ratios represent variables predictive of being a girl. CI = confidence interval.

Strategies Used for Navigating Social Situations

To explore the strategies used by children to manage early social settings carers provided free-report responses on the main strategy used in response to the question “during the preschool years do you think your child used any strategies to help them navigate social situations?”. Responses were coded into five categories: (i) no consistent strategy, (ii) mimicking, (iii) maintaining a close friend, (iv) isolating/withdrawing, and (v) talking to adults. After controlling for current age, social compensatory strategies significantly predicted sex, $Wald(4) = 15.49, p = .004$. As shown in Table 4, if a preference for mimicking as a social strategy was reported, the child was over 16 times more likely to be a girl. Indeed, 37% of the girls in the sample ($n = 20$) reportedly engaged in mimicking (i.e., copying/social scripts) as their primary strategy. This was the primary strategy for 10% of boys ($n = 8$). Isolating from play (i.e., leaving or remaining a passive observer) was the primary strategy for 30% of boys ($n = 24$), compared to 9% ($n = 5$) of girls. Engaging in conversation with adults was another common strategy for both girls ($n = 13, 24\%$) and boys ($n = 24, 29\%$).

Table 4

Results of Logistic Regression of Compensatory Social Strategies Used to Navigate Social Situations as Predictors of Sex

Strategy	Predicted Odds	<i>Wald</i> (1)	<i>p</i>	Exp <i>B</i> [95% CI]
Mimicking	<u>16.43</u>	5.76	.02	4.65 [1.31; 16.34]
Close friend	<u>4.21</u>	0.08	.79	1.19 [1.33; 4.26]
Isolating	1.66	1.75	.19	0.40 [0.10; 1.56]
Talking to adults	<u>3.28</u>	0.01	.91	0.93 [0.29; 2.98]
No consistent strategy (constant)	<u>5.53</u>	0.94	.33	2.31 [0.42; 12.81]

Note. Underlined predictive odds ratios represent variables predictive of being a girl. CI = confidence interval.

Sex Differences in Type of Restricted/Repetitive Behaviours (RRB)

Finally, carers free-reported on the most concerning type of obsessions/restricted interest held by the child during the preschool years (see Table 5 for regression results). Of note is that fascination with wheeled toys (cars, trucks) or parts of those toys was strongly predictive of being a boy ($n = 39$, 59%), with very few girls reportedly displaying this obsession ($n = 2$, 5%). In contrast, fascination with seemingly random objects (e.g., collecting shells, stickers) and obsessional/repetitive behaviour with toys (e.g., teddy bears, figurines, Barbies) were both predictive of being a girl. Thirty-three percent of girls ($n = 13$) were reportedly fixated with seemingly random objects, while 39% ($n = 15$) were fixated with their toys. These were rare fixations for boys (random: $n = 4$, 6%; toys: $n = 9$, 14%).

Table 5

Logistic Regression Results for Type of Restricted Interest of Most Concern During Pre-School Years Predicting Sex

Strategy	Predicted Odds	Wald(1)	<i>p</i>	ExpB [95% CI]
Wheeled-toys	13.54	5.14	.02	0.12 [0.02; 0.76]
Toys	<u>2.87</u>	4.37	.04	4.69 [1.10; 19.97]
Random	<u>1.82</u>	5.67	.02	2.98 [1.41; 33.40]
Screens	<u>1.82</u>	1.33	.25	2.98 [0.46; 19.17]
Character (constant)	1.63	0.52	.11	0.40 [0.06; 1.25]

Note. Underlined predicted odds ratios represent variables that predicted being a girl. CI = confidence interval.

Discussion

Cognitively-able girls with ASD are diagnosed substantially less and also later than boys (e.g., Begeer, et al., 2013; Rivet & Matson, 2011). Our study expanded current knowledge on why it may be more difficult to identify ASD in girls, through the examination of sex differences in the pre-diagnosis concerns held for the children who would go on to be diagnosed with ASD when school-aged. Results revealed sex differences across specific social concerns (externalising versus internalising), early signs (such as imitation), social strategies, and types of restricted interests, providing insight into why it may be more difficult to detect the early-signs of ASD in girls.

Sex Differences on the Social Domain

It has been theorised that one reason ASD is more difficult to detect in girls is that girls' social deficits (and abilities) present differently to that of boys (e.g., Attwood et al., 2006; Kopp & Gillberg, 1992). Our results provide some support for this hypothesis. Based on caregiver report, girls were more likely than boys to use mimicking to engage in the social environment, and were also more likely to have an unusually strong desire to fit-in with peers. Mimicking behaviour included reports of imitating adult interactions, peer interactions, or social interactions seen on television or in movies. This couples with carer report that girls were also more likely to engage in complex imitation. Only a handful of girls were reported to use isolation to manage social settings. In contrast, this was a commonly reported strategy for boys, with almost a third of boys reportedly isolating or withdrawing themselves from preschool social settings. The ability to mimic social interactions and attempts to actively connect with peers (e.g., unusually strong desire to be liked) may complicate the detection of potential deficits in the girl's underlying social understanding.

A surprising finding regarding carer concerns for social behaviour was that externalising behaviour was of greater concern for girls than boys, with externalising

behaviour the main concern reported for half of girls and only a quarter of boys. In particular, concerns with externalising behaviour commonly related to the child's strong desire to maintain stringent control over the play activity, with resulting 'melt-downs' if rules were not followed. In contrast, internalising behaviours (e.g., remaining passive or avoiding socialising) was more commonly a concern for boys. As this study was based on carer perspective, findings may be impacted by such factors as expectations of how boys and girls should socialise. Given all girls in this study eventually received a diagnosis of ASD, this finding may also reflect that girls' atypical development is more likely to be noticed when their behaviour is more difficult to manage. Indeed, significant concern with externalising behaviour appears to be a key reason that carers of girls seek professional opinion for their child's development. Consequently, our research does not rule out the possibility that girls may be at risk of being 'missed' if they do not also present with behaviours that are difficult for the carer to manage. Moreover, our research does not rule out the possibility that girls present as more introverted in a pre-school (teacher-observed) setting rather than parent-observed social setting. Indeed, our finding that teachers were less concerned with girls than boys, coupled with evidence of boys with ASD showing more problematic behaviour at school (Dworzynski et al., 2012; Hiller et al., 2014; Mandy et al., 2012) suggest home and school presentation are likely starkly different for girls with ASD. Potential differences between these two social settings remain an important avenue for future research, particularly given that conflicting reports of the child's social abilities at school (from teacher-report) versus home (from parent-report), would likely further complicate a family doctor or clinician's ability to determine if exploration of an ASD diagnosis is warranted.

Sex Differences in Restricted Interests

While research suggests girls present with fewer restricted/repetitive behaviours to boys (e.g., Mandy, et al., 2012), our analysis of the type of restricted interest of most concern

to caregivers, suggest it is possibly the nature of the interest that differs. The majority of parents of boys reported their primary concern regarding early restricted interests was the boys' non-functional use of wheeled toys (e.g., fixation with spinning wheels, lining up of cars; behaviours commonly associated with ASD). In contrast, this was only a concern for two girls. Girls were reportedly more likely to show obsessional interests with toys or seemingly random objects (such as collecting shells or feathers). There are numerous reasons, yet to be explored, which may explain why these different restricted interests may be more difficult to identify in girls. For example, girls' interests may be less intense than boys, which may mean they are less disruptive to the family unit and thus less likely to be reported as a concern. Alternatively, girls' interests may more closely reflect the interest of typically developing young girls, and thus be more difficult to detect as a sign of ASD.

Strengths, Limitations and Future Direction

Our study investigated caregiver perspectives on early concerns for the child's development. In doing so, we wished to investigate whether sex differences in early concerns may suggest the disorder would be more difficult to identify in girls. Nevertheless, we acknowledge some limitations to this study that may have impacted the results. First, the children's diagnosis of ASD was not re-confirmed. Moreover, the study relies on retrospective reporting. As with all studies that rely on retrospective reporting, we cannot rule out that current functioning may impact on perception of prior functioning. That is, carer perception of the child's current functioning may have impacted on their perception of the child's early behaviours. However, given the focus on sex differences, it is important to note that there were no differences in carer perception of the child's current functioning for girls versus boys. Further limitations were the use of an unstandardized online survey, and also basing DSM-5 clinician severity ratings on parent report. That said, the specific aim of this study was to gather information from the caregiver's perspective, given, particularly in the

pre-school years, they spend the most time with the child and are also the person most likely to voice concern about their child's development. We also specifically wanted to move away from exploring sex differences on standard ASD diagnostic instruments, which may not appropriately capture how the female profile may be different. Moreover, an advantage of the online survey format was our ability to access a larger sample of girls than what is commonly seen in the literature on sex differences. That said, this is the first study to explore sex differences in pre-diagnosis concerns, as well as sex differences in social strategies and carer perception on professionals' responses. The broad aims of this study, along with the exploratory nature, meant a relatively high number of analyses were required. Consequently, replication is warranted.

While we moved away from standardised diagnostic measures for the purpose of exploring the pre-diagnosis female profile, it is important to note that there were numerous similarities in the early concerns held for girls and boys (e.g., ability to manage change, lining up of objects, social concerns). This highlights the heterogeneity of ASD, regardless of sex. These similarities should be captured by typical diagnostic instruments. However, symptoms may be more difficult to detect in girls because of factors such as girls being better able to imitate, teachers being less concerned, using mimicking to manage social settings and different types of obsessions. As such, a key issue is likely improving professionals' understanding of how symptoms of ASD may present differently in girls, rather than the presence or absence of core symptoms. Exploring professionals' understanding of what ASD 'looks-like' remains an important avenue for future research, particularly given, based on carer perspective, it was quite rare for the family doctor to recognise signs of ASD when the carer first voiced concern (typically when the child was around three years of age). As part of this, it may be useful to explore in more detail the number of other diagnoses queried, or indeed given, prior to the ASD diagnosis. This may provide insight in to why a diagnostic

process would be delayed. Of note, while we did not find a sex difference in the age of diagnosis in the current sample, this is possibly simply because we have only focussed on 'later-diagnosed' children, and thus excluded children diagnosed in the pre-school years, where we may expect a greater gender imbalance. Finally, exploring sex differences in typically developing pre-schoolers would be beneficial, to ascertain whether sex differences found in this study reflect typical sex differences in young children.

Conclusion

Our results have provided insight into why ASD may be more difficult to detect early in cognitively-able females relative to males, using a novel method that explored carers' pre-diagnosis concerns held for children who would later be diagnosed with ASD. Based on caregiver report, there were key differences in early concerns for girls versus boys (e.g., imitation, interest in mechanical objects). Moreover, there was also evidence that girls used more 'active' strategies to manage social situations and presented with different types of restricted interests, both of which may alter the overt presentation of the disorder. Taken together these differences may make it more challenging for medical professionals and clinicians to identify potential early signs of the disorder in girls, and thus recommend a diagnostic assessment. Results highlight the importance of continuing to explore how the female profile may differ, particularly to aid the identification of how and why core deficits may present differently in cognitively-able girls, and thus improve our ability to early identify the disorder in this population.

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